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PALEONTOLOGY VERSUS GENETICS[1]

By Professor HENRY FAIRFIELD OSBORN

THE AMERICAN MUSEUM OF NATURAL HISTORY

AN interesting coincidence in the history of observation and speculation upon the nature and causes of evolution is found in the life studies of William Bateson and of the present author. In the years 1879 to 1882 Bateson was a student in the University of Cambridge. After an early zoological and embryological training he began an intensive study of variation as shown in recent osteological material, continued for a while in the biometric school and then became founder of the school of genetics. In the year 1879 the present author at the age of twenty-two was in Cambridge studying embryology under Balfour; he then took up studies in comparative anatomy and with Scott founded a new school of vertebrate paleontology.

[1] This article is an abstract of two addresses: "Bearing of Titanothere Researches on the Principles of Descent and Adaptive Radiation of the Mammals," American Philosophical Society, April 24, 1930; "Bearing of Titanothere Researches on the Principles of Mechanical Evolution," National Academy of Sciences, April 29, 1930.

William Bateson's theories and conclusions became increasingly negative; in 1893 he wrote: "If the study of variation can serve no other end it may make us remember that we are still at the beginning, that the complexity of the problem of specific difference is hardly less now than it was when Darwin first showed that natural history is a problem and no vain riddle."[2] In his presidential address of December 28, 1921, speaking as a geneticist, he made the following declaration:

> Discussion of evolution came to an end primarily because it was obvious that no progress was being made. We became geneticists in the conviction that there at least must evolutionary wisdom be found. When students of other sciences ask us what is now currently believed about the origin of species we have no clear answer to give. We can not see how the differentiation

[2] William Bateson, "Materials for the Study of Variation Treated with Especial Regard to Discontinuity in the Origin of Species," p. xii, London, 1894.

into species came about. Variation of many kinds, often considerable, we daily witness, but no origin of species. But that particular and essential bit of the theory of evolution which is concerned with the origin and nature of *species* remains utterly mysterious. The claims of natural selection as the chief factor in the determination of species have consequently been discredited. Our doubts are not as to the reality or truth of evolution, but as to the origin of *species*, a technical, almost domestic, problem.[3]

Osborn began paleontological studies in 1877 and more intensive research in the year 1890. On June 30, 1900, he succeeded Marsh as vertebrate paleontologist of the U. S. Geological Survey and at once began a most intensive geologic and biologic research on the evolution of the family of odd-toed ungulates known as Titanotheres from a name applied by Joseph Leidy to the jaw bone of *Menodus* discovered in 1846. The monograph on the Titanotheres covered twenty-nine years of research and exploration in New Mexico, Colorado, Utah, Wyoming, South Dakota, Montana, the Gobi Desert, Burma and the Balkans. The evolution of the Titanothere hereditary germ has accordingly been followed over a period estimated at ten million years from *Eotitanops* to *Brontops*. Comparison is made with the family tree of the odd-toed ungulates known as Perissodactyls showing the adaptive radiation of nine families and thirty-five subfamilies as compared with the Titanotheres which within a single family include twelve subfamilies, twenty-six genera and one hundred and six species, many of which are arrayed in close phylogenetic order.

This affords an unprecedented opportunity to contrast the zoological concept of Linnaeus of contemporaneous species with the modern paleontological concept of the origin and succession of species, subfamilies and families observed in close detail through long periods of time. Each minute part of many organs has been examined and precisely measured from its origin as it comes from the germ-plasm to its increasing importance into what may become an absolutely dominating character of the organism. This progression or retrogression is absolutely continuous and invariably definite and determinate rather than fortuitous. Characters rise and fall under twelve principles, three of which have been absolutely confirmed in the course of preparation of this monograph. The close analysis of thousands of separate characters gives us an entirely new concept of the origin of the "ascending mutations" of a genus. Inasmuch as every single one of the thousands of characters in the dental and skeletal mechanism is independently evolving, although constantly interrelated with all the other characters, a species is defined by one or more characters which reach a conspicuous stage either of progression or of retrogression. This is as true of paleontologic as of zoologic species, although in the latter case our definition is according to the eyes of Linnaeus and of Darwin, whereas in this paleontologic monograph we trace back to their origin the inconspicuous antecedents of each specific character.

It happens in the odd-toed ungulates such as horses, rhinoceroses and Titanotheres as well as in all other fossil mammals that conspicuous specific characters mostly include *allometrons* or changes of proportion, reduction or enlargement, and *rectigradations*, adaptively arising in new characters. Thus Leidy, Cope and Marsh independently divided Eocene horses by their successive rectigradations and allometrons.

In the Titanotheres, moreover, we enjoy the unparalleled opportunity of discovery that a genus consists not only of its visible generic characters but of invisible potential characters in the germ which may lie dormant for hundreds or thousands of years until they emerge. Moreover, each genus is characterized by different rates of velocities in the progression or retrogression of the thousands of characters which are embraced in its hereditary germ. For example, the horn and teeth rectigradations are hurried forward in one generic or subfamily phylum while they are closely guarded within the germ-plasm of another generic or subfamily line dwelling in the same geographic region. These origins of rectigradations are controlled by ancestral or potential heredity, whereas the origins of allometrons or changes of proportion respond directly to adaptive changes in environment.

The evolution of the Titanotheres has little to say about physical or chemical adaptations, but it gives us the most thorough and profound insight we have ever gained into mechanical adaptations. Altogether twelve principles are observed, the first nine of which are as follows: (1) principle of progression, development, of most useful mechanisms; (2) converse—retrogression, degeneration, of least useful mechanisms; (3) principle of compensation—gain of certain mechanisms compensated by loss of other parts; (4) principle of economy of mechanisms, related to principle of compensation; (5) principle of mechanical adaptation through ontogenetic or phylogenetic acceleration; (6) principle of mechanical adaptation through ontogenetic or phylogenetic retardation; (7) principle of mechanical autoadaptation of the individual, during ontogeny; (8) principle of coordination, correlation, coadaptation, of all the mechanical parts, ontogenetic and phylogenetic; (9) principle of organic selection of races which show highest powers of coincident mechanical autoadaptation and hereditary mechanical adaptation.

[3] William Bateson, "Evolutionary Faith and Modern Doubts," an address delivered on December 28, 1921, printed in SCIENCE, 55: 55–61, January 20, 1922.

Several of the above principles have been more or less fully known by anatomists, some of them reaching back of the time of Aristotle as treated in his "Physics" and in his "History of Animals." But the following three principles (10–12) are those which are first demonstrated in the Titanothere monograph although previously adumbrated in the author's earlier researches on the teeth of the Eocene primates and of the horses and rhinoceroses: (10) principle of allometrons, or adaptive changes of proportion in all the hard parts of mammals; (11) principle of rectigradations, or adaptive origins *versus* fortuitous or random origins of new characters; (12) principle of potential heredity, predetermination or emergence of rectigradations.

Whatever may be true as to fortuitous mutation and as to chance or random variation in chemical and physical adaptations, the mechanical evolution of the Titanotheres, a unique record of ten million years in the development of the Titanothere germ-plasm, shows absolute continuity in every single organ examined. There is not the slightest trace of discontinuity or of random origin.

Thus it may be claimed that the Titanothere monograph solves the chief principles involved in the origin of "ascending mutations," species, genera, subfamilies, etc., as displayed in the hard parts of mammals. There is a firm undeviating orthogenetic order in the entire animal mechanism. There is a phylogenetic continuity of germinal adaptation and reaction in response to secular changes of habit and of environment.

DUAL NATURE OF PHYSIOGRAPHY[1]

By Dr. WALDO S. GLOCK

OHIO STATE UNIVERSITY

IT may be held axiomatic that we live in a world which is active, dynamic and changing, in a world where energy is by nature more important, more universal, than matter. Causes arising from the flow of energy are elusive and difficult to formulate into natural laws; they seem to border too much upon the abstract. Effects impressed on matter are as a rule clearly visible and lend themselves to description, measurement and comparison. They are above all concrete. Therefore it is not wholly strange that physiography has developed to a great extent in the matter of description and interpretation of land forms.

However, physiography possesses a dual nature in causes and effects, in active forces and passive results. Geodynamics (even if necessarily modified by the word surficial) appears to be a good name for the study of those processes—active, dynamic, progressive—which are constantly at work molding the surface of the lithosphere. In contrast, geomorphology studies the physiographic products wrought by those same processes. Formal treatment of the subject, physiography, actually resolves the dual nature into two view-points, the one looking at the science in the light of activity, the other, of passivity. There remains the task of bringing out the contrasts between them.

GEODYNAMICS—THE ACTIVE PHASE

The so-called processes represent the forces at work, while the detailed surface features appear as the direct results; this is rather common knowledge. It is the attitude of approach and the method of treatment that may be radically new and different. In this case we refer to the dynamic view-point, which considers a stream to be the dominant factor in a fluvial environment, which accentuates the forces at work and represses the resultant products to mere incidents in the constant flow of energy. The stream, in fact, is the permanent, concrete reality of a situation. Geodynamics adopts the active view-point and seeks to analyze and understand intimately the physiographic processes, all the while cognizant of the fact that they are now and have been in the past at work on the land surfaces. This active phase of physiography contrasts vividly with the ordinary and purely passive study of earth form. The one is dominantly analytical and causative, the other descriptive and interpretative.

At first sight process and result depend vitally upon each other, since they are related as cause is to effect. They seem, indeed, to be inextricably interwoven—a slight variation in one either causes an equivalent change in the second or else is followed by a consistent response. These intimate relations may suggest of necessity a lack of reality in the dynamic view-point.

The absolute interdependence of process and product should not be assumed too strongly until another idea is considered. Let us imagine a comparatively resistant rock stratum forming a shoulder where it crops out on a valley wall. That stratum when first uncovered at the bottom of the valley no doubt influenced the rate of erosion and perhaps the exact position of the stream, but it did not alter or influence

[1] The work for this paper was carried on with funds made available by the research committee of the Graduate School of the Ohio State University

the fundamental nature of the agent or the characteristic activities whereby it pursued its habitual tasks. Corrasion and transportation, as processes, were not changed. Running water works on all rocks, hard and soft alike, and it is not the fault of the water if the hard rock is etched into relief.

Various streams do their work under a given (humid) climate in much the same manner almost or quite independent of underlying rock in a dynamic sense. They obey certain laws of their own, perform highly characteristic tasks and create a fluvial environment wherein the land surface responds to the sculpturing activities of the agent. It would seem reasonable to conclude, then, not only that physiography may be approached from a purely dynamic view-point but also that that view-point enjoys a measure and type of independence not shared by the other.

GEOMORPHOLOGY—THE PASSIVE PHASE

Geomorphology is concerned with the details of surface configuration expressed first by the origin of that form and second by the influence of lithology and rock structure. The method of origin has interest only because it explains and rationalizes important lineaments in the composition of the landscape. The form strangely enough is actually a transient, unstable affair connecting in its descriptive aspects with ecology and geography. The study of land form has thrived during the last forty years since the elucidation of the geographic cycle which, without doubt, stands out as the quintessence of geomorphological description.

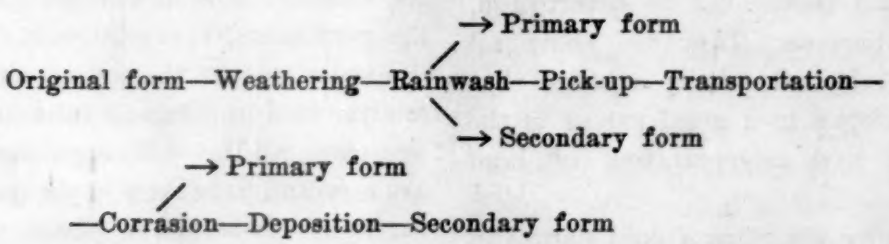
Primary and secondary physiographic features may be recognized as two fundamental types. The primary features originate in processes chiefly destructive and include such forms as valleys, ridges and mesas, whereas the secondary features result from activities chiefly constructive and refer to such forms as fans, deltas and flood plains.

RELATIONS

Geodynamics bears the same relation to geomorphology that cause does to effect. Perhaps it is the apparently abstract nature of processes which has caused the dynamical view-point to be slighted. The wind, the river and the undertow are more difficult to study than the sand dune, the valley and the beach. Streams after all constitute the life of a fluvial situation. They are in fact similar to life—cyclic and eternal ever since the time when they began. They are the immortal soul; sediments and disconformity, simply the "fossil" indications of their presence in the distant past.

The most interesting phase of geomorphology in many ways lies in the study of surface expression as influenced by lithology and rock structure. A full appreciation of surface detail can not be obtained, however, without a knowledge of the process involved, for, without the vitalizing fingers of that process at least mentally visible, the form lies cold and dead. The active forces shape the hills and valleys that blend and flow like clay in the hands of the artist.

A clearer idea of the relative importance, position and relationship of the active phase of physiography may be had if we introduce the idea of the dynamic interlude. Geologically, it includes the series of events changing original rock into resultant sediments; physiographically, it refers to those processes which carve the primary features out of the original, or initial, land form and finally produce the so-called secondary features. A skeletal outline will serve to illustrate the physiographic relations. The outline, not all-inclusive of course, actually represents an expanded form of the familiar erosion-deposition formula.



SUMMARY

Physiography may be viewed from two distinct angles, the one dynamic, the other passive. The processes hold the fascination inherent in energy and force; the products exhibit all the beauty and diversity of form in the composition of landscapes. The tacit adoption of a particular view-point not only will avoid confusion but will also simplify to a great extent both oral and written presentation of physiographic subjects, especially to beginners. We ought, perhaps, to discriminate clearly between process and product.

In a restricted fashion geodynamics studies the process, force or activity, simply acknowledging the form as a passive result. Geomorphology considers that form to be a detailed expression of the influence of rock and structure and acknowledges the process

as a cause chiefly in relation to the gross lineaments of the ensemble.

In a large fashion geodynamics is intimately associated with certain branches of geology, as sedimentation, while geomorphology connects physiography with geography. The dynamic interlude representing the active phase of physiography weaves the basic threads of geologic history.

OBITUARY

JESSE WALTER FEWKES

THE death of Jesse Walter Fewkes removes one who was an outstanding influence in the formative period of American archeology, particularly the archeology of our great Southwest. He was born at Newton, Massachusetts, on November 14, 1850, of parents whose ancestral lines in America extended back to the seventeenth century. In 1871 he entered Harvard and he graduated four years later with honors in natural history, besides being elected to membership in Phi Beta Kappa.

In 1874, while he was still an undergraduate, two papers on electrical subjects were published by him, but the year before he had come under the influence of Louis Agassiz in the latter's school at Penikese Island, Buzzards Bay, and this experience probably led him to turn his attention wholly to zoology. At any rate he took up graduate work in natural history and, after receiving the degrees of A.M. and Ph.D. in 1877, he continued zoological studies at Leipzig under Rudolph Lueckart between 1878 and 1880. Later he spent several months in Naples and at Villa Franca on the south coast of France as holder of the Harris fellowship. After his return to America he received an appointment as assistant in the Museum of Comparative Zoology at Harvard where, from 1881 to 1889, he had charge of the collections of the lower invertebrata. In 1881 he accompanied Alexander Agassiz to Key West and the Dry Tortugas for the study of marine life and two years later he visited the Bermudas on a similar quest. Every summer, from 1884 to 1887, he was assistant in charge of the younger Agassiz's marine laboratory at Newport, R. I., but in the spring of 1887 he pursued scientific studies at Santa Barbara, Santa Cruz and Monterey, California, as a guest of Augustus Hemenway, of Boston, and in the summer of 1888 he studied in Paris and engaged in field work in marine zoology at Professor Lacaze Duthier's zoological station at Roscoff, Brittany.

Dr. Fewkes's visit to California proved to be a turning-point in his career, for it was then that he came in contact with the culture of the Pueblo Indians, which excited in him an interest still further stimulated by the enthusiasm of Mrs. Mary Hemenway. In 1889 and 1890 he undertook field work among the Zuñi Indians of New Mexico, and in the latter year he made use of a phonograph—the first time, it is believed, that it was so employed—in the recording of Indian music. In 1891 he became director of the Hemenway Southwestern Archeological Expedition and editor of the *Journal of American Archeology and Ethnology*, established to publish the results of its investigations. During the same year he began those studies of Hopi ceremonials for which he became especially noted and which probably constitute his most enduring contribution to American anthropology. His description of the Hopi Snake Dance, which appeared in 1894, was a pronounced factor in spreading the knowledge of this striking rite and stimulating popular interest in it.

The Hemenway expedition having been invited by the Spanish government to participate in the Historical Exposition held at Madrid in 1892–93 to commemorate the discovery of America by Columbus, Dr. Fewkes was given charge of the exhibit and he was a member of the jury of awards. In recognition of these services he was honored by Maria Cristina, queen regent of Spain, with the decoration "Isabel la Católica," grade of knight. In 1894 King Oscar of Sweden presented him with a gold medal, "Litteris et Artibus," for his work in anthropology.

After returning to America Dr. Fewkes resumed investigations in the Southwest, but they were soon brought to an end by the death of his patroness, Mrs. Hemenway, in 1894. The collections made under his direction during this period are in the Peabody Museum at Cambridge.

In May, 1895, Dr. Fewkes received an appointment as ethnologist in the Bureau of American Ethnology at Washington along with the honorary title of collaborator in the division of ethnology in the United States National Museum, and the connection which he established with the bureau at this time continued unbroken until his resignation and retirement from active service in 1928.

This constituted a turning-point in his career in another direction because, although he continued to publish the results of his work among the living Hopi for many years afterward, his field excursions now became mainly archeological. From 1895 until 1901 the scene of these investigations was in and near the Hopi country in Arizona, but in 1902–04 he made a diversion to the West Indies in continuance of an interest

which he had exhibited as far back as 1891, and he devoted the field season of 1905 to northeastern Mexico.

With the passage of the Lacey Act in 1906 providing for the creation of public parks or "national monuments" a new era dawned in the history of Southwestern archeology, and the services of Dr. Fewkes were at once enlisted by the Department of the Interior for the exploration and restoration of ruins upon the public domain. In 1906 and 1907 he explored and repaired the famous Casa Grande ruins of southern Arizona, but in 1908 transferred his labors to the Mesa Verde National Park in southwestern Colorado and continued there through the field season of 1909.

In 1911, he returned to the West Indies, visiting Cuba, the Isle of Pines and Grand Cayman, and, in 1912, the Lesser Antilles, but the following spring he went to Europe where he spent part of his time studying the West Indian collections in German and Danish museums. In 1915 and 1916 he resumed work at the Mesa Verde.

On March 1, 1918, Dr. Fewkes was appointed chief of the bureau of which he had so long been an active member. However, this appointment scarcely interrupted the course of his field investigations, which continued until 1923 in the region of the Mesa Verde. The principal ruins excavated and repaired by him in that park during his entire period of service there were Spruce Tree House, Cliff Palace, Square Tower House, Painted House, Cedar Tree House, Pipe Shrine House and Far View Tower, while the Hovenweep and Wupatki National Monuments were created in 1923 and 1925, respectively, as the result of his suggestions. His last outdoor work of importance was the excavation of Elden Pueblo, near Flagstaff, Arizona, in 1926.

As chief of the Bureau of Ethnology Dr. Fewkes also found time to interest himself in the archeology of the southeastern part of our country which he visited several times. His most important undertaking here was the excavation of the Weeden Island mound, near St. Petersburg, Florida, in the winter of 1923–24, and it is characteristic of his archeological optimism that his very last expedition consisted in a "reconnaissance" of the Piedmont region of South Carolina in June, 1927, looking toward more extensive investigations at some later period.

In April, 1925, Dr. Fewkes had to undergo a severe operation and, while he returned to the field, as noted, in 1926 and 1927, he never recovered fully from its effects. After his return from the South in 1927 he suffered a fall and, as a result of it, became so much weaker that on January 15, 1928, he resigned as chief but continued on the staff of the bureau until November. His death took place on May 31, 1930, his wife, who had been his constant field companion, preceding him by a few weeks.

Dr. Fewkes was a member of the National Academy of Sciences and an honorary or corresponding member of many scientific societies, American and foreign. He was secretary of the Boston Society of Natural History from 1889 to 1891, vice-president and chairman of Section H of the American Association for the Advancement of Science in 1901 and again in 1915, president of the Anthropological Society of Washington in 1909 and 1910, president of the American Anthropological Association in 1911 and 1912, and for more than thirty years he was on the visiting committee of the Peabody Museum of Harvard University.

In January, 1915, he was the official representative of the Smithsonian Institution at the inauguration of Dr. KleinSmid as president of the University of Arizona and had bestowed upon him by that institution the degree of LL.D. On the occasion of his seventieth birthday, November 14, 1920, a luncheon was given in his honor at the Smithsonian building, participated in by about forty of his friends, and a specially bound volume of letters of congratulation was presented to him. His last public act was the presentation of a bust of Louis Agassiz to the Hall of Fame on behalf of the American Association for the Advancement of Science and an unnamed admirer of the great naturalist. This took place on May 10, 1928, Dr. Fewkes being the only pupil of Agassiz then living able to be present.

His publications include, besides the two papers on electricity already mentioned, nearly seventy contributions to invertebrate zoology, mainly the Medusae, Echinodermata and Vermes, and about two hundred contributions to ethnology and archeology.

Dr. Fewkes was possessed of a genial and confiding nature and an effervescent enthusiasm which drew people to him and made them readily communicative of any information they happened to have regarding new types of ruins, unique pottery or mounds which had escaped scientific eyes, so that, from the quantity point of view, he was almost uniformly successful in his field expeditions. And in this way he made many openings for later workers, even though he did not exploit all the possibilities of an undertaking. For he was interested in variety of material, especially material of a novel character, rather than in associations of material, and the extension of his work interfered with its intensiveness. However, his unaffected pleasure in a new variety of artifact or an exceptional pottery design was something that the average man could understand and through his talks to tourists and in the lecture hall, and through press interviews,

he interested hundreds to whom a more rigorous student might have spoken in vain. In this way he created a "Pueblo consciousness" which drew other investigators to the field and provided popular support for their work, performing a similar service to that of Cushing at an earlier date on the side of ethnology. Thus the title "dean of American archeology" which, with advancing years, some of his admirers came to apply to him was not inappropriate. It was a term which his charm of manner set off to most excellent advantage, and he had a devoted circle of friends who will feel that his going has removed something peculiarly warm and winning from their lives.

JOHN R. SWANTON

RECENT DEATHS

COLONEL WILLIAM BOYCE THOMPSON, mining engineer and copper operator, who founded the Boyce Thompson Institute for Plant Research with an endowment approaching ten million dollars and who gave other large sums for public purposes, died on June 28 at the age of sixty-one years.

PROFESSOR CHRISTEN LUNDSGAARD, professor of internal medicine at the Royal University of Denmark at Copenhagen, formerly an associate of the Rockefeller Institute for Medical Research and a member of the American Society for Experimental Biology and Medicine, died on June 16. He was forty-seven years old.

Nature reports the death of Mr. Arthur Stanley Hirst at sea on May 4. Mr. Hirst was formerly an assistant keeper in the British Museum (Natural History). He was born in 1883.

DR. J. B. BRADBURY, for the past thirty-six years professor of medicine in the University of Cambridge, died on June 4 at the age of eighty-nine years.

THE death is announced of Dr. Kiyoo Nakamura, director of the Central Meteorological Observatory of Japan.

MEMORIALS

Industrial and Engineering Chemistry reports that the Northeastern Section of the American Chemical Society, through a committee composed of Lyman C. Newell, Arthur D. Little and James F. Norris, has announced the establishment of a gold medal to commemorate the many fundamental contributions made to chemistry by Theodore William Richards. The medal will be awarded by the Northeastern Section at intervals of two or three years for conspicuous achievements in chemistry, and is being designed by Cyrus E. Dallin, a sculptor who was an intimate friend of Professor Richards. An opportunity is offered the friends of Professor Richards to assist in securing the sum of ten thousand dollars which is required to cover the initial expenses and provide a trust fund yielding sufficient income for the successive medals and incidental expenses.

DEDICATION ceremonies for Atwater Laboratory, the new building to house the animal disease and the genetics departments of the Storrs Agricultural Experiment Station, Connecticut, were held on June 12. The laboratory of brick and brown stone, two stories and a basement, was erected at a cost of $42,000. It was named for Wilbur O. Atwater, professor of chemistry at Wesleyan University, first director of the Storrs Station and of the United States Office of Experiment Stations. On the program of the dedication were Dr. Edward C. Schneider, professor of physiology at Wesleyan; Dr. Edward H. Jenkins, director emeritus of the experiment station, and Dr. A. F. Blakeslee, vice-director of the Carnegie Station for Experimental Evolution in Cold Spring Harbor, L. I., formerly professor of botany at the Connecticut Agricultural College, Storrs. Dr. George Alan Works, president of the college, presided. Guests from many colleges and research institutions attended the ceremonies and the luncheon that followed.

IN commemoration of the twenty-fifth anniversary of the discovery of the spirochete that is the causative agent of syphilis, memorial exercises in honor of the discoverer, Dr. Fritz Schaudinn, were held, May 17, in the Zoological Institute, Berlin. At the same time, his workshop or laboratory was dedicated as the "Schaudinn Room." Professor Max Hartmann and Professor Hesse delivered the memorial addresses.

SCIENTIFIC EVENTS

NATIONAL HYDRAULIC LABORATORY

ON May 14 last, the following bill was signed by President Hoover:

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That there is hereby authorized to be established in the Bureau of Standards of the Department of Commerce a national hydraulic laboratory for the determination of fundamental data useful in hydraulic research and engineering, including laboratory research relating to the behavior and control of river and harbor waters, the study of hydraulic structures and water flow, and the development and testing of hydraulic instruments and accessories: Provided, That no test, study or other work on a problem or problems connected with a project the prosecution of which is under the jurisdiction of any department or independent agency of the government shall be undertaken in the laboratory herein authorized until a written request to do such work is submitted to the

Director of the Bureau of Standards by the head of the department or independent agency charged with the execution of such project: And provided further, That any state or political subdivision thereof may obtain a test, study or other work on a problem connected with a project the prosecution of which is under the jurisdiction of such state or political subdivision thereof.

Sec. 2. There is hereby authorized to be appropriated out of any money in the Treasury not otherwise appropriated, not to exceed $350,000, to be expended by the Secretary of Commerce for the construction and installation upon the present site of the Bureau of Standards in the District of Columbia of a suitable hydraulic laboratory building and such equipment, utilities and appurtenances thereto as may be necessary.

A number of government departments have a long list of urgent problems awaiting solution, and the experiments in connection therewith will be taken up in the new laboratory as soon as it is completed. Among these are questions relating to large reclamation and water conservation projects in the West, the control of erosion below spillways and dams, losses of head in large pipe and channel bends, the flow of water over dams, the entrainment of air at tunnel and syphon entrances, the regulation of rivers, the laws of silting and erosion in drainage ditches and streams, and the improvement of instruments and devices for measuring flowing water.

Owing to the great variety of problems which will be submitted for study, the equipment of the new laboratory will be designed to furnish the greatest possible flexibility of arrangement and combination, so that it can be adapted easily to the simultaneous study of a number of different problems.

The fixed equipment will include electrically driven pumps for circulating the water, a large concrete water-supply basin, a concrete measuring tank, several steel weighing tanks, elevated control tanks for supplying water under several different fixed heads, a standpipe and piping systems for distributing this water to all parts of the laboratory and for returning it from the models under test to the supply basin. A large unobstructed floor will be provided where a number of models can be built and tested simultaneously.

WEATHER FORECASTS FOR AIRWAYS

THE Weather Bureau is organizing an expansion of its service in aid of aviation, which will provide frequent and regular weather reports covering approximately 13,000 miles of airways. Effective soon after July 1, these reports will provide sufficient detail to meet all needs.

On about 8,000 miles of these airways teletype lines will provide 24-hour communication with exchange of reports once each hour. The remaining 5,000 miles will be served by reports transmitted by telephone or telegraph and at such intervals as will best meet current needs. On nearly 3,000 miles of airways, over which there is as yet comparatively little flying (one or two daily flights each way), the bureau will provide a limited service.

The current reports along all of these airways are supplemented by specialized, short-period airways forecasts which are based primarily on the twice-daily, country-wide reports and weather maps used in the general forecasting service, and, secondarily, on a series of three-hourly reports concentrated at designated centers from a well-selected network of stations. Some of these reporting stations are on the airways and others are at a considerable distance from them. At present the centers to which these reports go and from which the short-period forecasts are issued are the airport stations at Cleveland, Ohio; Fort Crook, Nebraska; Salt Lake City, Utah, and Oakland, California. After July 1, the increased appropriation will enable the bureau to open three new offices, at Atlanta, Georgia, at Dallas, Texas, and at Portland, Oregon. About 110 reporting stations will transmit to these forecasting centers.

Bulletins and short-period forecasts based on these reports will be sent by teletype from the seven centers to other airports and to landing fields and will also be broadcast to aircraft in flight through a rapidly expanding network of radio stations maintained by the Department of Commerce.

The Weather Bureau's program provides for the establishment of observation from pilot balloons at several additional stations, including Albuquerque, New Mexico; Cincinnati, Ohio; Dallas and Del Rio, Texas; Elko, Nevada, and North Platte, Nebraska.

Outside of continental United States, the bureau is increasing its airways service in Alaska, where a new first order station is being organized at Nome. Pilot balloons will be stationed at Nome and Fairbanks. The service in the Hawaiian Islands will include a chain of inter-island stations from which reports will be transmitted by radio to Honolulu, there to be made available for the information of pilots flying from one island to another.

The Weather Bureau also announces that it is continuing its investigations with kites, captive, pilot and sounding balloons and airplanes (through cooperation with the Navy Department), and is now engaged also in studies of ice formation on aircraft, turbulence or gustiness and other problems. The bureau's appropriation for all phases of its airways forecasting and study is $1,400,000.

APPOINTMENTS AT THE ROCKEFELLER INSTITUTE

THE Board of Scientific Directors of The Rockefeller Institute for Medical Research announces the

following appointments and promotions on the scientific staff.

New Appointments: Assistants—J. Lionel Alloway, Albert J. Anthony, James V. Bickford, Laurie L. Burgess, Frank Cortese, Macdonald Dick, Robert C. Elderfield, Filip C. Forsbeck, Kenneth Goodner, Benjamin E. Hodge, Stephen S. Hudack, Lewis G. Longsworth, Margaret J. Pittman, Paul D. Rosahn, William B. Rose, Kenneth C. Smithburn, Douglas H. Sprunt, Radford C. Tanzer, Robert Thomas, Robert S. Tipson and G. Payling Wright. Fellow—Basile J. Luyet.

Promotions: Associate Member to Member—Peter K. Olitsky. Assistant to Associate—Mortimer L. Anson, Robert B. Corey, René J. Dubos, Rebecca C. Lancefield, Currier McEwen, Alfred E. Mirsky, Albert L. Raymond, Julius Sendroy, Jr., Richard E. Shope. Fellow to Assistant—Fred Smith.

Resignations: Charles A. Doan to become professor and chairman of the department of medical and surgical research of Ohio State University; Robert R. Hannon, associate professor of medicine, Peiping Union Medical College; James A. Hawkins, associate professor of applied biochemistry, department of ophthalmology, Washington University Medical School, St. Louis; Louis A. Julianelle, associate professor of applied bacteriology and immunology, Washington University Medical School; William S. Tillett, associate professor of medicine in charge of the department of biology, Johns Hopkins Medical School.

THE DEPARTMENT OF PHYSICS OF HARVARD UNIVERSITY

As reported in the *Harvard Alumni Bulletin*, members of the staff of the Harvard department of physics will spend the summer vacation in writing, travel and research as follows:

Professor P. W. Bridgman will be engaged in writing at his summer home in Randolph, New Hampshire. Preparation for his research on the properties of matter under high pressure at the Jefferson Physical Laboratory will be carried on during his absence by an assistant.

Professor William Duane will supervise his general X-ray research in connection with the work of the Harvard Cancer Commission, both at the Harvard physical laboratories and the bio-physical laboratories at the Huntington Hospital. He will also supervise the installation of a radium plant at the Palmer Memorial Hospital.

Professor F. A. Saunders, of the Jefferson Laboratory, will revise his "Laboratory Manual on General Physics" and will be occupied with the plans for the new physics laboratory.

Professor E. L. Chaffee, of the Cruft Laboratory, will spend the vacation at his summer home in Ludlow, Vermont, where he will complete the first volume of his textbook on radio vacuum tubes.

Professor N. H. Black, of the Jefferson Physical Laboratory, will be on sabbatical leave during the academic year 1930–31. He will study the methods of teaching science at the English public schools—Eton, Harrow, etc. —and later will engage in research at the Cavendish Laboratory, University of Cambridge.

Professor E. C. Kemble, of the Jefferson Laboratory, will give courses on quantum mechanics and molecular spectra at the summer session at Cornell University.

Professor J. C. Slater, of the Jefferson Laboratory, will be engaged in writing a volume on the quantum theory of the structure of atoms, molecules and solids at his summer home near Rochester, New York.

Professor R. F. Field has resigned from the staff of the Cruft Laboratory and accepted a position as research engineer at the General Radio Company, Cambridge, Massachusetts.

F. H. Crawford, instructor in physics, will spend the first half of the summer vacation in research on band spectra at the Jefferson Laboratory.

Of the instructors in physics at the Cruft Laboratory, H. R. Mimno will continue his research on radio frequency amplifiers, F. V. Hunt will be engaged in the calibration of acoustic measuring devices, R. W. Hickman will continue his work on gas-filled vacuum tubes and W. N. Tuttle will travel in England, Holland and Germany, visiting the great physical laboratories of those countries.

HONORARY DEGREES FROM THE UNIVERSITY OF NEW HAMPSHIRE

THOMAS A. WATSON, Boston; Wilton E. Britton, New Haven, and Ambrose Swasey, Cleveland, were among those receiving honorary degrees from the University of New Hampshire. The citations given were as follows:

WILTON EVERETT BRITTON—Entomologist of the Connecticut Experiment Station; Connecticut State Entomologist; graduate of this institution in the Class of 1893; horticulturist in Connecticut for six years; teacher in the Yale Forestry School; doctor of philosophy from Yale University. Your steady progress in the great science to which you have given your life—the science that protects the crops of the farmer and makes safe the food supply of the nation—has been rewarded during the years by many and marked honors. You have been the president of the American Association of Economic Entomologists and for twenty years the associate editor of the *Journal*. You have served one state for almost four decades, but your influence has gone far beyond its borders. Your devoted labors have won for you international reputation in your profession, a reputation of which your Alma Mater is justly proud.

THOMAS AUGUSTUS WATSON—On the last page of a delightful life story you have written these words—"mountains have always reminded me of my telephone days, probably because my first sight of them was so impressive on the notable day I spent in North Conway,

New Hampshire, in December, 1876, when I talked with Alexander Graham Bell in Boston over the first long line over which we tried the telephone.'' You were the first to hear human speech ''by telegraph''—from Cambridge and Conway to Boston, and from San Francisco and London to New York. You, moreover, made with your own hands the first telephone, and besides many other contributions you invented the bell that drives so many busy men, and even women, to the woods. You probably have the distinction of making the greatest single contribution to the jangling distraction of this noisiest of worlds. During twenty-five arduous years you founded and created one of America's great shipyards; you have been a pioneer of organized kindergartens; joint author of the geology of the Boston Basin; president of the Boston Browning Society; producer of Browning's dramas and interpreter of them even to the city of culture. Your accomplishments have been indeed varied and extraordinary. To-day New Hampshire claims you not because of the love of her mountains which crept into your soul in '76 to abide forever, not because your father was a native of near-by Newmarket, neither because in these latter years you find the center of New Hampshire the one place for rest and worship in the summer season, but because of the splendid breadth of your achievements both in science and art, and the hunger for beauty and truth which with the zest of youth still possesses and consumes you.

AMBROSE SWASEY—Native of beautiful Exeter and her constant friend and benefactor, manufacturer, captain of industry, inventor, scientist, philanthropist, founder of the Engineering Foundation, fellow of the Royal Astronomical Society, chevalier of the Legion of Honor and builder of the world's greatest telescopes including the Lick and the Yerkes. You have made it possible for mortals to peer into the near-by yet remote spaces of the illimitable universe, and to understand as never before the pregnant phrase, ''What is man that thou art mindful of him and the son of man that thou visitest him?'' You have combined the superlative practical achievements of creative business so delightfully with lofty idealism that those of us who know you are prompted to insist that institutions as well as individuals should hitch their wheels to ever nobler purposes. Recipient of honors too numerous to mention, you have been justly and fittingly decorated in many places and many lands. Your friends and neighbors view them all with sincere pride and joy. Yet, now, because you have been one of New Hampshire's most loyal, as well as one of her most distinguished sons, it seems fitting that we should here, to-day, place side by side with your other notable recognitions and rewards a simple wreath of home-grown bays.

SCIENTIFIC NOTES AND NEWS

ON the occasion of the installation of Mr. Stanley Baldwin as chancellor of the University of Cambridge on June 5 the recipients of honorary degrees included Professor Albert Einstein and Professor Max Planck, of Berlin; Sir John Rose Bradford, president of the Royal College of Physicians, and Sir James Colquhoun Irvine, principal of the University of St. Andrews.

THE dedication ceremonies of the new medical building of the University of Brussels were held on June 24. The buildings were erected jointly by funds provided by the Rockefeller Institute and the city of Brussels. The degree of *doctor honoris causa* was conferred on Dr. Simon Flexner, director of the Rockefeller Institute, and on Dr. Abraham Flexner, formerly of the Rockefeller Foundation, who was recently elected president of the newly established Institute for Graduate Study at Newark, New Jersey.

IN recognition of his contributions to electrical science, Thomas A. Edison received a gold medal on June 20 at his laboratory in West Orange from a delegation representing the Argentine Association of Electro-Technicians. The presentation was made by William Asher Reece, president of the General Electric Company of the Argentine. Supreme Court Justice Owen J. Roberts presented on June 26 the John Scott Medal and an accompanying award of $1,000 to Mr. Edison at his laboratory, in recognition of "outstanding contributions to science."

THE Polytechnic Institute of Brooklyn held its seventy-fifth annual commencement on June 18, the speaker being Dr. Frank Pierrepont Graves, Commissioner of Education of the State of New York and alumnus of the institute. The honorary degree of doctor of engineering was bestowed upon President Karl T. Compton, of the Massachusetts Institute of Technology, and on Mr. Charles F. Kettering, president of the General Motors Research Corporation. The degree of Admiral Richard Byrd, who was delayed in returning to the United States, will be conferred upon him at a special convocation in the fall.

AT its seventy-fourth commencement Tufts College conferred the doctorate of science on Mr. Arthur D. Little, president of the Arthur D. Little Corporation.

CAPTAIN NICHOLAS HUNTER HECK, chief of the Division of Terrestrial Magnetism and Seismology of the U. S. Coast and Geodetic Survey, received from Lehigh University at its recent commencement the honorary degree of doctor of science.

DR. ZAY JEFFRIES, consulting metallurgist of Cleveland, delivered the address at the forty-third annual commencement of the South Dakota State School of

Mines on June 5. It was the twentieth anniversary of Dr. Jeffries' graduation from the institution which bestowed upon him the degree of doctor of engineering.

THE Pharmaceutical Society of Great Britain has placed on its distinguished roll of honorary members the names of the retiring dean, Dr. Henry H. Rusby, and Dr. Henry V. Arny, the dean-elect of the College of Pharmacy, Columbia University. These honors were awarded because of the scientific achievements of Dean Rusby and Dean-elect Arny and also to emphasize the cordial relations which have existed for a number of years between the School of the Pharmaceutical Society in London and the New York college.

THE current quarterly issue (June) of the *Annals* of the Association of American Geographers is entirely devoted to "An Appreciation of the Contributions to Earth Science of Albert Perry Brigham." In the words of the inscription, "This issue of the *Annals* is gratefully and admiringly dedicated to Albert Perry Brigham on his seventy-fifth birthday in recognition of his inestimable services to the Association of American Geographers and to the science of geography." Seven papers deal with Professor Brigham's career as follows: "Personal Sketch," by Professor R. E. Dodge, Agricultural College of Connecticut; "Geologist," by Dr. Philip S. Smith, U. S. Geological Survey; "Physiographer," by Dr. Kirk Bryan, U. S. Geological Survey; "Human Geographer," by Professor R. H. Whitbeck, University of Wisconsin; "Popularizer of Geography and Geology in the United States," by Colonel Lawrence Martin, Library of Congress; "Geographer-Envoy from America to Europe," by Professor Frank E. Williams, University of Pennsylvania, and "Educator," by Professor Robert M. Brown, Rhode Island College of Education. There is a recent portrait by Bachrach, and a full list of Dr. Brigham's books and papers.

DR. LAFAYETTE B. MENDEL, of Yale University, was elected to the staff of the Connecticut Agricultural Experiment Station, New Haven, at a recent meeting of the board of control. His title is research associate in biochemistry. Dr. Mendel collaborated with the late Dr. Thomas B. Osborne, who was in charge of the experiment station biochemistry department, in studies of nutrition that commanded world-wide recognition. Since Dr. Osborne's death, the work has been carried on with Dr. H. B. Vickery, who is now head of the laboratory of biochemistry. The action of the board of control is taken to recognize officially a relationship that has existed for years. Dr. Mendel is Sterling professor of physiological chemistry at Yale and chairman of the department of physiology and physiological chemistry.

DR. MARGARET C. FERGUSON, of Wellesley College, has been appointed research professor in botany and given the aid of a full time assistant. This was made possible through the generosity of Miss Susan Minns, of Boston.

DR. F. J. SIEVERS, director of the Massachusetts Agricultural Experiment Station, was recently elected to serve also as director of the graduate school at the Massachusetts Agricultural College following the resignation of Dr. H. T. Fernald.

AT Cornell University Professor Madison Bentley has been granted a year's leave to occupy the chairmanship of the division of anthropology and psychology in the National Research Council. Professor K. M. Dallenbach, who is lecturing this summer at the University of Oregon, will also be on leave during next year. He will be visiting professor of psychology at Columbia University and his place at Cornell will be temporarily filled by Professor John G. Jenkins, of the Iowa State College at Ames. Mr. Robert Brodie MacLeod has been appointed instructor at Cornell to take the place of Dr. George Kreezer who goes to Germany as a national research fellow in the biological sciences.

PROFESSOR H. R. ROBINSON, professor of physics at University College, Cardiff, has been appointed professor of physics at the East London College of the University of London to succeed Professor C. H. Lees who will retire.

THE new portfolio of fisheries in the Canadian Cabinet will be filled by Dr. Cyrus MacMillan, of McGill University, a representative of Prince Edward Island.

DR. O. E. HARDER, in charge of the department of metallography in the University of Minnesota, has been appointed an assistant director of the Battelle Memorial Institute. Dr. Harder will devote part of his time to the work being conducted at the institute by the alloys of iron committee of the Engineering Foundation.

MR. ROBERT J. MOORE, for the past six years general research chemist of Pratt and Lambert, Inc., Buffalo, N. Y., has resigned to become development manager of the Varnish Resin Department of the Bakelite Corporation. Mr. Moore will work under Dr. L. V. Redman, vice-president in charge of research and development, at the Bloomfield Division, New Jersey. He will be concerned with the application of the newly developed Bakelite resins in air-drying varnishes, enamels and lacquers.

MR. RALPH T. K. CORNWELL, senior microanalyst of the National Institute of Health (Hygienic Lab-

oratory), U. S. Public Health Service, Washington, D. C., has resigned to accept a position with the Sylvania Industrial Corporation of Fredericksburg, Virginia.

DR. WARD B. WHITE, for the last eight years director of the bureau of chemistry, New York State Department of Agriculture and Markets, has accepted an appointment as chief of food control, Food, Drug and Insecticide Administration, to fill the vacancy caused by the death of R. W. Balcom.

MR. S. J. COOK, chief of the Mining, Metallurgical and Chemical Branch, Dominion Bureau of Statistics, Ottawa, has been elected general secretary of the Fifth Pacific Science Congress, which for the first time will visit Canada in 1932.

DR. WALTER F. WILLCOX, of Cornell University, will represent the United States at the International Institute of Statistics which meets in Tokyo in September.

DR. PAUL BARTSCH and assistants have left Washington for a four months' cruise and exploration of the Bahamas and islands lying southward. A 70-foot vessel with an oil-burning engine was chartered at Miami, Florida, from which place they sailed on June 9. The expedition is made possible by the granting of the Walter Rathbone Bacon Traveling Scholarship.

DR. H. E. GREGORY, of Yale University and head curator of the Bernice P. Bishop Museum, Honolulu, visited Washington recently to inspect exhibits of Polynesian objects at the U. S. National Museum, principally from Samoa, the Hawaiian Islands, New Zealand, and the Hervey, Cook and Easter Islands with the object of negotiating an exchange of duplicate material between the National and the Bishop Museums.

DR. MAURICE L. TAINTER, associate professor of pharmacology in the Stanford University School of Medicine, left on June 19 for six months' study and travel abroad.

DR. MCKEEN CATTELL, assistant professor of physiology in the Cornell Medical College, New York City, sailed on June 28 for England, where for eight months he will be engaged in physiological research.

THE sixth International Congress of Genetics will be held at Ithaca, New York, from August 24 to 31, 1932, under the presidency of Dr. Thomas Hunt Morgan.

AT the meeting of the Seventh International Ornithological Congress at Amsterdam, Professor Lönnberg, of Sweden, was president, and Professor L. F. De Beaufort, secretary. The membership was larger than at any previous congress, being over 300. In addition to lectures by experts in different branches of the science, excursions were arranged to protected areas to see the rich bird life of Holland. At the final meeting on June 7 it was announced that the congress would in future be held every four years, instead of every five years; that the next meeting would take place in London in 1934, and that the president would be Dr. E. Stresemann, of Berlin, and the Rev. F. C. R. Jourdain, of Southbourne, Bournemouth, would be secretary.

THE third Imperial Entomological Conference opened on June 17. The meetings of the conference were, by courtesy of the Entomological Society of London, held in the society's new council room and were attended by delegates from the governments of twenty-four dominion, colonial, etc., governments, in addition to representatives of the Imperial College of Tropical Agriculture, Trinidad; the East African Agricultural Research Station, Amani, and government departments in the United Kingdom. At the opening meeting, which was confined to delegates, the conference discussed the work and finances of the Imperial Bureau of Entomology. Visits were arranged to the Parasite Laboratory of the Bureau at Farnham Royal, to Cambridge and to the Rothamsted Experimental Station and the Pathological Laboratory of the Ministry of Agriculture at Harpenden. The subjects of the various sessions were as follows: the organization of entomological departments, entomological work among backward races, tsetse-fly control, the control of insects by cultural methods, locusts, the biological control of insects, the control of weeds by insects and the control of orchard pests.

FOUR o'clock Saturday afternoon public lectures will be given during July and August in the lecture hall of the New York Botanical Garden. The subjects and lecturers are as follows: July 5. "The Philippine Islands," Dr. Elmer D. Merrill, director-in-chief; July 12. "Porto Rico: Its Flora and Scenery," Dr. Marshall A. Howe, assistant director; July 19. "Plant Traps," Dr. John Hendley Barnhart, bibliographer; July 26. "Diseases and Pests of Ornamentals," Dr. B. O. Dodge, plant pathologist; August 2. "Fungi, Edible, Poisonous and Otherwise Interesting," Dr. Fred J. Seaver, curator; August 9. "Florida," Dr. John K. Small, head curator of the museums; August 16. "Fossil Plants of New York City and Vicinity," Dr. Arthur Hollick, paleobotanist; August 23. "Wild Flowers of Late Summer," Dr. Forman T. McLean, Supervisor of Public Education, and August 30. "Growing Plants in Artificial Climate," Dr. J. M. Arthur, Boyce Thompson Institute.

DISCUSSION

ON THE ALLEGED EFFECT OF POLARIZED LIGHT ON FILMS OF STARCH

IN SCIENCE[1] there was published last summer a note describing the observations concerning the action of polarized light reported by Miss Semmens at the Cape Town meeting of the British Association for the Advancement of Science. This note pointed to the very striking result that a beam of moonlight—known to be polarized—was able to hydrolyze (to simple sugars apparently) boiled starch carried in films on filter-paper. Her demonstration was based on the fact that objects able to cast shadows on the disks of paper left traces revealed on developing with an iodine solution. The shadows or zones not exposed to radiation were said to appear slightly deeper in color than the exposed parts.

At that moment the *Scientific Transactions* of the British Association[2] was not available to give more information as to her procedure, but from the note referred to we tried to repeat these experiments both with moonlight and with artificial illumination. Since then we have had access to the original abstract of the communication, but unfortunately it is scarcely more explanatory. It was attempted to have our technique as close to hers as could be guessed from the abstract.

Disks of filter-paper (four different makes represented by nine different types of paper as to size of grain), were treated with different solutions of starch (corn, potato and soluble starch) at concentrations ranging from 0.5 per cent. to 5 per cent. The filter-paper was thoroughly washed with distilled water (cold or boiling). These disks were used under three conditions: thoroughly wet, damp and air-dried. Some were exposed on a glass plate, the shadow-casting objects being made of brass, steel, bakelite and blocks of glass covered with black paper. Care was taken to mark with suitable points the corners of the blocks. In a few cases, also, the whole procedure was carried out in a Petri dish. We irradiated the objects perpendicularly to the plane of the paper, taking the trouble to reorient the carrier of the disks every fifteen to thirty minutes when moonlight was used. We checked also the fact that the moonlight was polarized. The artificial light used was a thousand watt bulb whose rays were passed through a large Nicol prism; heat filters were placed between lamp and prism; the spectrum of the light extended from 420 mμ to 700 mμ. Some controls in the dark and in ordinary light of the same intensity as the polarized light were run at the same time. The intensity of illumination varied from 57 m. c. to 550 m. c.; the duration of irradiation ranged from fifteen minutes to six hours. The development of the disks was done with different concentrations of Lugol's solution diluted so as to give a color ranging from barely visible to deep blue-black coloration.

Our results were striking in their consistency: in no circumstances could the author or persons called to judge the differences in colors (and all these were familiar with the iodine starch reaction) detect any difference that could be related to the supposed phenomenon.

If Miss Semmens's contention is correct, there must have been present in her procedure some as yet unrecorded feature. It is at least apparent, however, that the alleged effect can not be of general occurrence.

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[1] SCIENCE, 70: xiv, August 30, 1929.
[2] See *Scient. Transact.*, Brit. Assoc. Adv. Sci., Meeting South Africa, p. 12 and 70, 1929.

INCREASED ACCURACY IN THE DETERMINATION OF CARBONATES IN SOIL

IT has been known for a long time that in the determination of carbonate in soils carbon dioxide is frequently obtained from some soil constituent other than carbonate minerals, and that the amount so obtained is likely to be greater if the soil is unusually rich in organic matter and comparatively strong hydrochloric acid at a high temperature is employed for decomposing carbonates. With many soils the error from this cause is by no means negligible when 1:10 hydrochloric acid at room temperature or even 1:50 acid at 30° C. *in vacuo* is used. The source of carbon dioxide is commonly considered to be the soil organic matter, but no detailed explanation of the reaction involved has come to the writer's attention.

Considerable evidence has been secured indicating that this error is due to oxidation of organic matter to carbon dioxide, as the result of reaction with manganese dioxide native to the soil and the added acid. Not only is the amount of carbon dioxide obtained from sources other than carbonates increased by addition of powdered manganese dioxide to the soil prior to acid treatment, but also determinations of the active manganese dioxide in the soil by measurement of oxygen evolved from soil and 15 per cent. hydrogen peroxide indicate for similar soils a relation between this active manganese and the carbon dioxide obtained by acid treatment.

Addition of ferrous chloride to the acid reduces carbon dioxide from this source to a very small amount when 1:50 hydrochloric acid at about 30° C.

is employed for decomposing soil carbonates. With considerably stronger acid or at a higher temperature there is a slight error, but by the use of 1:10 acid with ferrous chloride at the temperature noted it is possible to recover very accurately all carbon dioxide from the most resistant dolomite mixed with soil. With some soils it has been noted that the results secured by use of the stronger acid are more accurate than those with a weaker reagent and longer time of action. It is evident that time of action as well as concentration of acid and temperature is a factor, and that oxidation is probably not the only reaction involved, although it may be the most important.

The decomposition of soil carbonates should therefore be effected at the lowest temperature and with the most dilute acid that can be used, consistent with recovery of all carbon dioxide from resistant carbonates in a short time. By the use of a special reagent to prevent oxidizing action the accuracy of the determination is greatly increased. It is planned to publish at an early date a detailed description of an apparatus and procedure for the determination of soil carbonates, including the above and other improvements in technique, whereby the determination can be conducted with the utmost certainty of correct results in a shorter time and with less trouble than is possible with any method previously described.

C. J. SCHOLLENBERGER
OHIO AGRICULTURAL EXPERIMENT STATION, WOOSTER

THE BEHAVIOR OF SUDAN III WHEN FED WITH CARBOHYDRATE

THE significance of the use of Sudan III in the study of fat metabolism is based on the observations of several investigators,[1] who have shown that this fat-soluble dye when mixed with a fat or oil is readily absorbed from the alimentary tract and is deposited in adipose tissue. The writer has found, in the course of some experiments on fat metabolism, that not only does a stained fat result in deposits of colored fat in the body, but cornstarch plus Sudan III will give the same results in white rats, six to eight weeks old or older, after four days of feeding only cornstarch and a large amount of dye. Similar results were obtained when the extraneous fat occurring in cornstarch was removed and this extracted cornstarch plus Sudan III was fed. Since it was thought possible that the fatty acids attached to a complex carbohydrate in corn α amylose might be responsible for the transport of the dye, other carbohydrates, such as sucrose, lactose and dextrin, were each fed separately with Sudan III. Each animal was allowed only distilled water from 5 P. M. one day until 8 A. M. the next day. The dye, one gram in eighty grams of the carbohydrate, was mixed with the dry material and fed without the addition of any other foodstuff. Five well-matched lots of five animals each were run on the following carbohydrates, cornstarch, rice-starch, dextrin, lactose and sucrose. In each case the dye was deposited especially in subcutaneous fat and the fat around the intestines and the testes. Exceptions were noted, however, in very young rats that became emaciated on this diet, and on autopsy, after four or five days, almost no fat was seen in the body.

Negative results occurred after feeding only two days, perhaps because the animals had not yet taken enough of the dye to show color. On the third day faint pink fat was noted in those animals autopsied, and on the fourth and fifth days unmistakable coloring of adipose tissue was found.

During the feeding of these animals results were noted that have been recorded by other writers, that the urine became pink in a day or two and that the feces were very dark red when first excreted and later became black and hard.

It has been claimed that Sudan III clings to the fat or fatty substance of the food with which it is fed and that it must be borne in mind that fat is necessary for the transport of the dye. In the present experiments, the question as to whether or not the dye fed with carbohydrate attaches itself to fat in its course through the body or whether fat is synthesized from the carbohydrate fed and deposited as colored fat can not be answered now.

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ANTHOCYANIN AS AN INDICATOR

IN connection with the article by O. B. Pratt and H. O. Swartout on "Fruit and Vegetable Pigments as Indicators" (SCIENCE, May 9, 1930, p. 486), I would like to call attention to an article by Professor W. J. Gies and myself, published in 1918 (*Proc. Soc. Exp. Biol. and Medicine*, 16, 8 (1918)) on plant pigments, in which the suggestion was then made that anthocyanin (obtained from the tulip, crimson king, etc.) could be used as an indicator. In fact, the properties of this anthocyanin were compared with phenolphthalein and it was shown that the range of the former varied from pH 5.3–9.2.

BENJAMIN HARROW

[1] Gage and Gage, "Sudan III Deposited in the Egg and Transmitted to the Chick," SCIENCE, 28: 494, 1908; "The Coloration of Milk in Lactating Animals and the Staining of Growing Adipose Tissue in Suckling Young," *Anat. Rec.*, 3: 203, 1909; Mendel and Daniels, "The Behavior of Fat-soluble Dyes and Stained Fat in the Animal Organism," *Jour. Biol. Chem.*, 13: 71, 1912–13.

SCIENTIFIC BOOKS

The Epidemiology and Control of Malaria in Palestine. By ISRAEL J. KLIGLER, director, department of hygiene, Hebrew University, Jerusalem. The University of Chicago Press, 1930.

DR. ISRAEL J. KLIGLER, formerly of the American Museum of Natural History, later of the Rockefeller Institute and since 1921 working in Palestine, first as director of laboratories of the Hadassah Medical Unit, later with the Malaria Research Unit and since 1926 professor of hygiene in the Hebrew University, Jerusalem, has written an excellent book.

He thinks that the static condition of Palestine during the last several centuries is due almost entirely to malaria. While some antimalaria work was done in Egypt before the World War, nothing seems to have been done in Palestine until after the close of the great struggle. In 1921, however, Dr. Kligler took up such a study under the auspices of the Hadassah Medical Organization, then the American Zionist Medical Unit. The present book gives the results of the work since that time. Dr. Kligler is a broad medical investigator, but he is not a trained entomologist. Fortunately, in 1923 Dr. P. A. Buxton held the position of medical entomologist to the British government of Palestine and submitted a report published in the *Bulletin of Entomological Research* for March, 1924, the bulk of which was devoted to entomological matters of medical or veterinary interest. I imagine that the mosquito material collected by Dr. Buxton must have passed through the hands of the entirely competent culicidologist, F. W. Edwards, of the British Museum of Natural History. Therefore Dr. Kligler in his work is without doubt sound when he refers to the different species of Anopheles by name. He considers eight species of Anopheles, and his keys are based upon those of Buxton. The book is well planned and well illustrated, and the author shows a thorough familiarity with recently published work in different parts of the world. His chapters include: I. Topography and Climate; II. Social, Economic and Health Conditions; III. Actual and Potential Breeding Places of Anopheline Mosquitoes; IV. Bionomics of the Anopheles of Palestine; V. Incidence and Etiology of Malaria; VI. General Considerations of the Epidemiology; VII. Methods of Control; VIII. Results of Control Work; IX. Experiments with Various Control Measures in Districts where Antilarval Control was Unsuccessful. There is an appendix on typical drainage work of a permanent character. The book is therefore the result of a broad study, and all important facts have been considered carefully and at some length.

The methods of control are in the main those that have been used in other parts of the world, but there have been in Dr. Kligler's work some interesting variations. The brothers Sergent in Algeria were probably the first to suggest as a mechanical method the frequent changing of irrigating streams from one canal to another, bringing about the drying up of anopheline larvae. Dr. Kligler found it simple, with the breeding places caused by springs, to deflect the flow in a different direction from the natural course every five or six days, or, by damming the stream, storing the water behind the dam for two or more days and then releasing it, excellent results could be reached. Several variations of this general plan were tried with good effect. He insists, however, upon thorough drying, since he has found that the older larvae may remain alive for a considerable time in moist earth. Variations in the oiling method are described, and these experiments showed that the addition of 1 per cent. by volume of castor oil to a kerosene film is very advisable. Paris green was used in the proportion of one part to one hundred parts of fine sifted road dust or ashes.

The native cyprinodont fish are not effective as destroyers of larvae. They are not top-feeders. Imported Gambusias, however, were much more satisfactory, and they now occur in fairly large numbers in the open drainage canals and pools.

The volume contains much original and useful matter and should be very useful to antimalaria workers everywhere.

L. O. HOWARD

SCIENTIFIC APPARATUS AND LABORATORY METHODS

ELECTRODYNAMIC RECORDER

UNDER ordinary circumstances the kymograph upon which the responses of a stimulated muscle are recorded must be placed at no great distance from the muscle. With the device herein described, an attempt has been made to provide a means whereby kymograph records can be made at any convenient distance from the stimulated tissue.

The apparatus (Fig. 1.) is actuated like the direct, kymograph recording equipment now in use, *i.e.*, the muscle is hooked to a thread which, passing over a

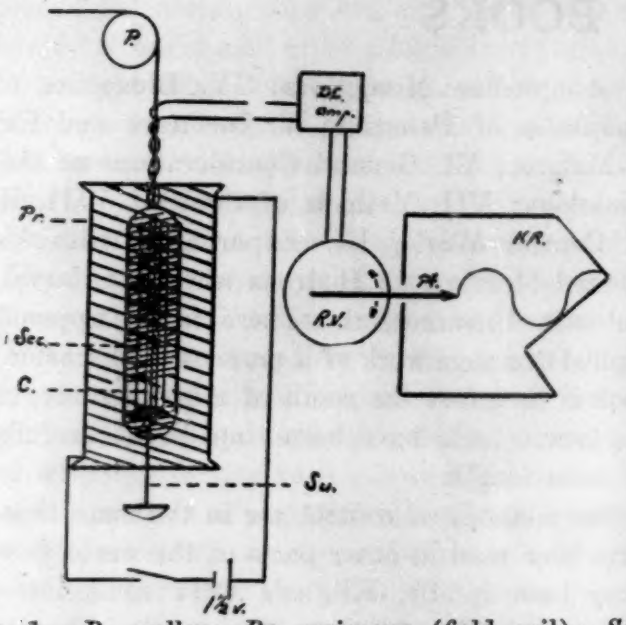

FIG. 1. *P.*, pulley; *Pr.*, primary (field coil); *Sec.*, secondary (moving coil); *C.*, soft iron core; *Su.*, weight support, or spring substitute; *D.C. amp.*, direct current amplifier; *R.V.*, recording voltmeter; *Pt.*, pointer; *K.R.*, kymograph record.

pulley, raises and lowers a specified weight or pulls against a spring of given substitute-weight. In this case, instead of the thread activating a pointer, a soft iron core around which is wound many turns of fine wire is raised and lowered in the magnetic field of a helix of heavy wire through which a small current passes. The core together with its secondary winding cuts the magnetic lines of force in the field, and a current is set up which operates a dead-beat, zero-center, recording voltmeter equipped with a light pointer and so adjusted as to record on a moving kymograph drum. A one or two-step D. C. amplifier in the secondary circuit provides a means of controlling the amplitude of the pointer-arc.

By varying the length of the wires between the movable iron core and the voltmeter it is possible to make records at any convenient distance from the research laboratory in which the activated muscle may be placed, *e.g.*, records may be made before a large class in the lecture room.

A detailed description of the electrodynamic recorder has been omitted because it is assumed that laboratory research means the fitting of fundamental apparatus to specific uses. (For certain uses, the recorder may be wired in such a manner that the movable core carries the energizing current, while the outer helix becomes a part of the secondary circuit.) It is felt, however, that the extreme sensitivity of the device, the simplicity of construction and the advantage of remote recording will recommend the apparatus to experimenters in physiology and psychology.

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A SIMPLE AQUEOUS ELECTRODE

IN threshold studies of sensitivity to high frequency E.M.F. stimulation the writer has devised a simple aqueous electrode which has proved very satisfactory in laboratory experimentation.

The complete electrode, schematized in Fig. 1, is a modified Mandler diatomaceous bacteriological candle

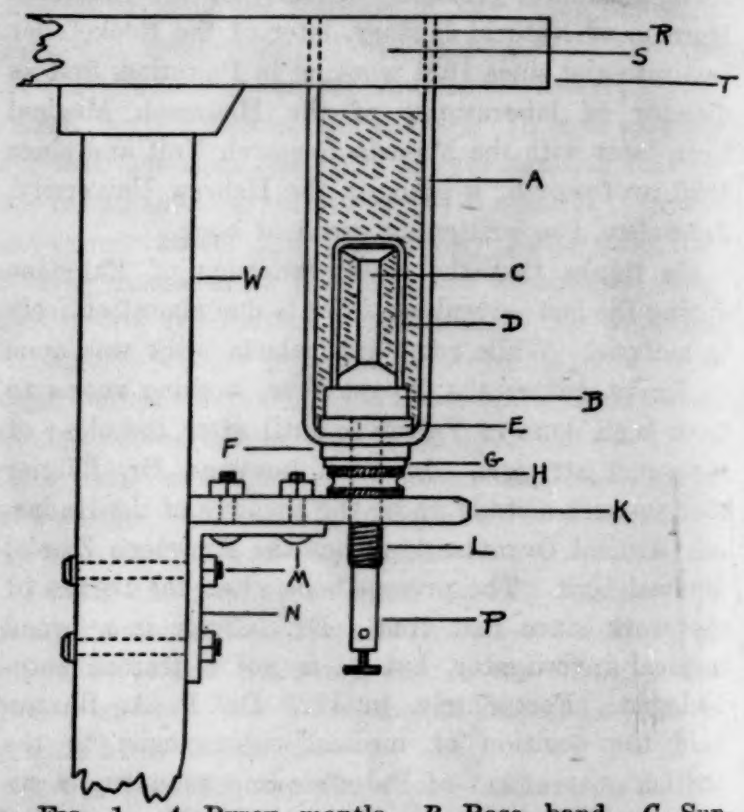

FIG. 1. *A.* Pyrex mantle. *B.* Base band. *C.* Supporting electrode. *D.* Inverted glass tube serving as finger rest. *E.F.* Soft rubber washers. *G.* Fiber washer. *H.* Brass lock-nut. *K.* Wooden base supported by right-angle iron. *L.* Threaded nipple. *M.N.* Fastening bolts. *P.* Binding post. *R.* Mantle protruding through writing ledge, *T.* *S.* Hole in writing ledge through which subject inserts finger. *W.* Fore leg of chair.

enclosed in a pyrex mantle. After the filter is removed, the base band, the concave drainage and the nipple are sealed, thus rendering the mantle liquid tight. By means of interposed cushion-rubber washers, the nipple lock-nut fastens the base band securely against the bottom of the pyrex mantle. A brass binding post is soldered to the lower end of the sealed nipple.

In place of the diatomaceous candle, a T-electrode is substituted which supports an inverted glass tube acting as finger rest. Filtered water is used as the liquid conductor. The electrode is not reliable when used in connection with psychogalvanic direct current circuits. It is quite effective, however, when used in connection with an inductorium as source. Since alternating current of relatively high frequency is employed as the stimulus, danger of polarization is eliminated.

The complete electrode is supported at the lock-nut

juncture by means of a right-angle iron attached to the anterior surface of the fore leg of a study chair. The top of the mantle conveniently passes through a circular hole in the writing ledge of the study chair. The writing ledge acts as an arm and finger rest for the subject. The mantle can be quickly removed from its supporting position and thoroughly cleaned without difficulty.

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SPECIAL ARTICLES

THE MYOGRAM OF THE ISOLATED SKELETAL MUSCLE CELL

THE determination of the contractile mechanism of a muscle cell from results procured in experiments upon an intact muscle presents the difficulty of differentiating between those factors attributable to the cellular process *per se* and those due either to a statistical distribution of the contractility of the fibers or to mechanical interference of the connective tissue enclosing the fibers. Moreover, the methods employed give no approach to the functional significance of the recognized structural elements within the muscle cell. The present investigation was undertaken, therefore, to develop a method of investigating the contractile and structural properties of single isolated muscle fibers. Opportunity is taken at this time to present a preliminary report of the results. A complete account will be published later.

METHODS

The method is to mount the single muscle fiber upon the tips of two glass needles, one needle being rigid, while the second, the micro-lever, is flexible so that its tip is free to move when the muscle contracts. The needles, mounted in a Chambers' micro-manipulator, are held in the field of a microscope. The image of the movable lever is projected upon the slit of a recording camera and adjusted at right angles to the slit by means of a suitable optical system.

For the glass micro-lever used it has been determined that the displacement of the tip of the lever is a linear function of the force applied.[1] The contraction curve of the muscle, therefore, can be converted into absolute units when necessary.

The micro-levers have a period of about 0.0016 seconds. This is a sufficiently short period for recording the contractions of these muscle fibers.

The muscle cell is stimulated by break induction shocks applied by silver-silver chloride micro-electrodes.

Preparations of the isolated cells of the sartorius muscle, 1 cm to 1.5 cm in length, are used. These are mounted in a hanging drop of frog serum in the customary moist chamber.

[1] The method of calibrating the glass micro-levers will be published elsewhere by the junior author.

RESULTS

The results obtained can be described to the best advantage by reference to the records of the contractions in Fig. 1. These records show the following:

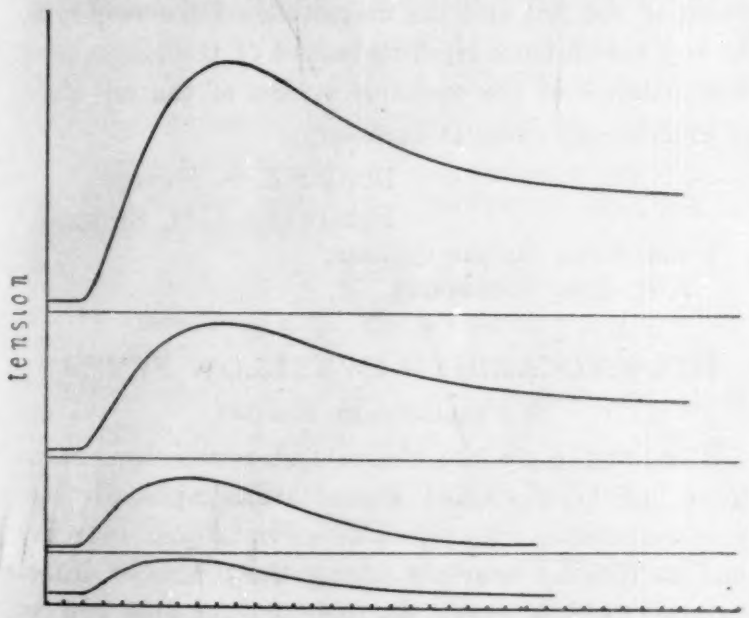

FIG. 1. Myograms from a single isolated fiber of the sartorius muscle showing a progressive increase in the magnitude of each response with increasing strength of stimulus. Temperature 23° ± 2° C. Time intervals represent 0.01 seconds.

(1) In the simple twitch of a skeletal muscle fiber the tension at the beginning of contraction rises abruptly, increases to a maximum, and then decreases to zero in a curve without discontinuities. No plateau or angle such as described by Fulton[2] for the intact muscle exists. These results are in agreement with those of Cooper and Eccles,[3] who ascribe Fulton's results to frictional interference in the muscle lever he used.

(2) An increase in the strength of stimulation results in an increase in the total tension developed and in the duration of the contraction. With strong stimuli the recovery from contraction is not complete, a new base line being reached.

[2] J. F. Fulton, Williams and Wilkins Co., 1926.
[3] S. Cooper and J. C. Eccles, *J. Physiol.*, 69, 1930; *Proc. Physiol. Soc.*, III.

The variation in the magnitude of contraction with variation in the strength of stimulus indicates that the all-or-none law does not apply to the electrically stimulated muscle cell. Gelfan[4] has reached a similar conclusion for the fibers of the retrolingual membrane of the frog stimulated *in situ*. Before a definite conclusion can be reached in the present investigation it is necessary to determine whether the stimulating current is affecting only the excitable system involved in any type of stimulation no matter how produced, or whether there are also direct electrochemical effects of the current upon other components of the cell. Some evidence that such changes are involved has been obtained and the subject is now under investigation from the view-point of the relation between the chronaxie of the cell and the magnitude of the response. In any case a more rigid statement of the all-or-none law in terms of the excitable system of the cell than is customarily given is necessary.

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THE MYOCARDIUM IN YELLOW FEVER[1]

A PRELIMINARY REPORT

A SERIES of twenty rhesus and cynomolgus monkeys has been studied electrocardiographically before inoculation with yellow fever virus (Asibi strain) and at varying intervals during the course of infection with yellow fever. Of these animals only two recovered from the disease. The functional changes in the sino-auricular node, auricular muscle, auriculoventricular bundle and ventricular muscle recorded by electrocardiography have been compared with the histopathological changes in the corresponding cardiac tissues of each animal.

Bradycardia, regular in rhythm, absolute in degree and progressively more marked on succeeding days of the disease, has been a constant finding in experimental yellow fever in the monkey. The heart rate in these animals has been reduced in varying degrees ranging from 75 to 30 per cent. of the normal frequency. The bradycardia persisted independently of ether anesthesia and sodium iso-amyl-ethyl barbiturate anesthesia, and following bilateral section of the vagus nerves. This retardation of cardiac rhythm was associated with hyaline, granular, vacuolar and fatty degenerative lesions in the musculature of the sino-auricular node. In the animals which recovered from the disease the normal heart rate was gradually resumed.

Occasionally reduplication of the P wave of the electrocardiogram was observed in experimental yellow fever; more rarely this deflection was seen to be inverted. Well-marked degenerative changes have been found in the auricular muscle.

Prolongation of the conduction time of the auriculoventricular bundle, as measured by the P-R interval of the electrocardiogram, was observed in slight or moderate degree in 84 per cent. of cases. With few exceptions the delay in conduction was progressive, increasing from day to day of the disease. The P-R periods regained their normal values in the animals which recovered. This impairment of conduction was associated with the appearance of granular, fatty and vacuolar degeneration in the fibers of the auriculoventricular bundle.

Among electrocardiographic alterations in the ventricular muscle during the course of the disease, changes in ventricular preponderance were commonly observed. The R-T period was lengthened in 94 per cent. of cases, and frequently it was deformed. The T wave commonly took an early origin from the descending limb of the R wave or the ascending limb of the S wave with concurrent distortion of the R-T segment of the ventricular electrocardiogram. The normal upright T wave was replaced in 76 per cent. of the cases by a deflection either negative in direction or diphasic in contour, the latter change being represented either by two waves above the line of equipotential or by one positive and one negative wave in relation to the base line. In addition to these types of deformity of the terminal deflection, an upright T wave of increased height was frequently observed. These abnormal variations of the ventricular electrocardiogram appeared most frequently on the later days of the disease; but these disturbances were transient, fleeting in nature, present in one tracing and not in another, one type of variation being inscribed upon one occasion, a different deformity appearing during subsequent annotations. Their occurrence was associated with the presence in the ventricular muscle of these animals of hyaline, granular, vacuolar and fatty degenerative lesions.

A detailed account of which the above is a summary is in preparation and will be published in the near future.

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[4] S. Gelfan, *Amer. J. Physiol.*, 93: 1, 1930.

[1] This work was performed under the tenure of a grant from the Banting Research Foundation. The electrocardiographic studies were carried out in the Yellow Fever Laboratory of the Rockefeller Foundation and in the Physiological Laboratory of the Rockefeller Institute in New York, through the kindness of the directors of these laboratories, Dr. W. A. Sawyer and Dr. A. E. Cohn.